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ABSTRACT

The main focus of contemporary research in writing is on developing ideas and on the processes of planning and revision that make this possible. In the first half of this paper, the distinctive strategies used by experts and novices are elaborated. For example, novice writers depend upon having knowledge already assembled in forms ready for written presentation, while experts can bring more complex knowledge-processing procedures to bear to transform knowledge into coherent and effective form. Data from a variety of research projects and from national assessments are presented which indicate that novice strategies prevail throughout the elementary and high school years and including, in many cases, the university years. In the second half of the paper, data from research that aims to foster more expert strategies are presented. In the work reported, students are provided with explicit instruction in procedures used by experts, thus gaining knowledge about procedures that foster reflective analysis. Through the described procedures, students learn to analyze carefully and work more effectively with specific knowledge structures. A five-page list of references concludes the document. (JD)

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HIGHER ORDER ABILITIES: WRITTEN COMMUNICATION

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The Nature of Higher Order Abilities in Written Composition

"I wrote even if only for myself. I could not think unless I did so."
--Jean Piaget

The main focus of contemporary research in writing is on developing and integrating ideas and on the processes of planning and revision that make this possible. Results from national assessments of school-age writers (National Assessment of Educational Progress, 1975, 1977, 1980a, 1980b), as well as assessments of university students (Cooper, Cherry, Gerber, Fleisher, Copley, and Sartinsky, 1979) confirm that the most prevalent problems are of this ideational sort rather than problems of grammar, spelling, sentence structure, and the like. In other words, the "writing problem" reflects the same problems of higher-order knowledge and skills that have created a general concern about the intellectual quality of contemporary education (United States National Commission on Excellence in Education, 1983). The present paper focuses on recent progress in understanding the higher-order problems of writing and in developing new instructional means for dealing with them.

Novice writers depend on having knowledge already assembled (either in memory or through teacher-directed writing activities) in forms ready for written presentation. Experts can bring more complex knowledge-processing procedures to bear to transform knowledge that is not so assembled into coherent and effective form. Accordingly, what we see in the performance of expert writers is the execution of powerful procedures that enable them to draw on, elaborate, and refine available knowledge. For novices, by comparison, writing serves more to reproduce than to refine knowledge.

Unlike many abilities dealt with in school, reading and writing have as their basis language abilities that occur naturally, that tend to be highly automated, and that enable considerable, untutored competence. These naturally occurring aspects of language use in reading and writing have received a great deal of attention (Clay, 1975; Goodman, 1967; Graves, 1983; Harste and Burke, 1980; Rentel & King, 1983; Smith, 1971).

The strong emphasis that has been placed on aspects of written competence that

develop naturally has, however, tended to obscure the effortful, higher order processes needed to manage the more natural processes of expression. The case for distinctions between relatively automated abilities supported by ordinary social interchange and more purposefully constructed, effortful abilities has been made for a broad range of school abilities (Brown, Bransford, Ferrara & Campione, 1983). Distinctions between expert and novice performance in writing as well as in various other domains can in a sense be considered distinctions between routine use of available knowledge and subordination of this knowledge to more strategic processes (Evans, 1984; Resnick, 1983; Reif & Heller, 1982; White, 1984).

In the first half of the current paper the distinctive strategies used by experts and novices are elaborated. Then data from a variety of research projects and from national assessments are presented which indicate that novice strategies prevail throughout the school years, including, it seems, the university years. In the second half of the paper data from research that aims to foster more expert strategies is presented. In the work reported students are provided with explicit instruction in procedures used by experts. They thus gain knowledge about procedures that foster reflective analysis. At the same time the procedures they learn to execute require more careful analysis of the information they put in their texts. Thus developing higher order competence in writing is tantamount to working more effectively with specific knowledge structures. (See the accompanying paper labeled "Teaching Students to Think as they Read: Implications for Curriculum Reform," by A. L. Brown for a parallel argument in the area of reading comprehension). The effort thus sidesteps the issue of whether to teach general thinking skills or domain-specific knowledge by providing the alternative of teaching the means experts use to refine their knowledge.

The Acquisition of Higher Order Competence: From Conversation to Knowledge Telling to Knowledge Transforming

Conversation to knowledge telling. The child who comes to school already a proficient user of oral language has a number of hurdles to get over on the way to becoming a proficient writer. Generally, these hurdles have to do with problems of sustaining discourse without the numerous kinds of support provided by a conversational partner. There are problems in

thinking of what to say, in staying on topic, in producing an intelligible whole, in making choices appropriate to an audience not immediately present. At a deeper level there are problems such as searching memory without the help of a conversational partner. These are significant problems, but there are natural solutions. One solution is to stick to telling stories or relating personal experiences. But for expository writing, which students find themselves having to face sooner or later, the natural solution is the strategy that has been labeled knowledge telling (Bereiter & Scardamalia, 1983; in press-a; Scardamalia & Bereiter, in press-b). This strategy was expressed by a 12-year-old student as follows:

> I have a whole bunch of ideas and write down until my supply of ideas is exhausted. Then I might try to think of more ideas up to the point when you can't get any more ideas that are worth putting down on paper and then I would end it.

The strategy is a think-say strategy. The writer uses cues signalled by the topic and by the type of discourse required. For example, given the assignment "Should animals be kept in zoos?" topic cues might be "animals" and "zoos" and the question format signals the need to present, minimally, a statement of position and a reason. The first idea that meets topic and discourse specifications is presented. This new sentence along with the assignment, serve, in lieu of a conversational partner, as cues for what to say next. This think-say process continues until the page is complete or the store of ideas that comes to mind is depleted. It is not assumed, of course, that the writer consciously formulates the memory probes, any more than the producer of a sentence consciously formulates the need for a certain part of speech. On the contrary, we assume that the process is most of the time rapid and virtually automatic. This does not mean that knowledge telling is easy or unstressful. Often it is quite the opposite (Daly & Miller, 1975). But knowledge telling does turn writing into a routine that makes maximum use of external cues and cues generated from language production itself. It requires no significantly greater amount of planning, revision or goal-setting than does ordinary conversation. It is serviceable, even though it does not answer to the culture's highest needs. Hence it should be little wonder that such an approach to writing is often retained on into university and career, even if its shortcomings become increasingly

significant.

Knowledge telling is capable of many refinements, but refinements do not make the novice into an expert. The essential design features of the knowledge-telling model are that it generates content by topical and structural prompts, without formulation of goals, subgoals, search criteria, and other components of problem solving. So long as these essential features remain, the composing process retains its knowledge-telling character and remains fundamentally distinct from the expert knowledge-transforming processes.

Knowledge Telling to Knowledge Transforming. Clear indications of a model of writing distinct from knowledge telling may be obtained by looking at graduate students. Although they may not be expert writers by literary standards, these more advanced students give evidence of a distinctly more complex approach to writing than do younger students. This more complex approach is marked by an active reworking of knowledge as it is used in writing (Flower & Hayes, 1981; Scardamalia & Bereiter, in press-a). This reworking or transforming of knowledge has been described in a variety of ways by professional writers (Lowenthal, 1980; Murray, 1978; Odell, 1980). Aldous Huxley described the process as follows:

> Generally, I write everything many times over. All my thoughts are second thoughts. And I correct each page a great deal, or rewrite it several times as I go along.... Things come to me in driblets, and when the driblets come I have to work hard to make them into something coherent. (cited in Writers at Work, 2nd series, 1963, p. 197.)

What follows is a brief overview of the kinds of mental activities identified in expert composing. It is through these mental activities that experts sustain self-definition of constraints and goals.

Alternating, Checking, and Coordinating Procedures. Experts alternate between types of composing activities (e.g., generating content and detecting problems), check the adequacy of courses of action that they have embarked on, and manage to coordinate the various results of these efforts. Basically, they execute self regulatory strategies--strategies

for managing their cognitive behavior. As we have seen, the executive structures that guide the composing processes of novice writers tend not to have these capabilities.

Searching for Relevant Knowledge. Searches for content appropriate to a text appear as odysseys through hard-to-get-at memory stores for experts while they appear as non-problematic, take-what-comes-next, operations for novices. The search strategy that has been examined most carefully is that of elaborating constraints (Flower and Hayes, 1980a, 1980b). The expert elaborates constraints and thus generates more conditions for solution than the novice. The effect of elaborating constraints is to produce an integrated analysis of the problem. By comparison, the novice uses the givens of the assignment rather than personally elaborated constraints. Accordingly, the number of constraints to be dealt with is less, but so is the potential for activating, integrating and reformulating content.

Constructing Mental Representations of Text. In order to solve problems with their texts writers must have ways of representing their text to themselves. Text can be represented at many different levels. The lowest levels include near photographic, verbatim, and paraphrase representations. The highest levels include representations of main point and purpose. Mature writers produce integrated networks that coordinate high- and low-order representations. Immature writers give evidence of unintegrated representations at lower levels (Burtis, Bereiter, Scardamalia & Tetroe, 1983; Scardamalia & Paris, in press). These findings are in keeping with distinctions between the knowledge-transforming model--a model whereby goals are generated and problem solving involving representations of intention and main point are involved--and the knowledge-telling model--a model for generating text without the need to operate on high-level representations.

Pervasiveness of Novice Strategies

Indications that novice strategies prevail throughout the school years include:

Limitations on revision. Expert writers check what they produce against goals and translate perceived deficiencies into problems to be solved. The expert strategy thus encourages revision. Knowledge telling, the novice strategy, does not incorporate means for

assessing high level goals and thus substantive revision is neither necessary nor likely to prove rewarding. The notion that knowledge telling dominates even the university years is supported by the consistent finding that revision, even among university students, is largely limited to proofreading, cosmetic alterations, spelling, punctuation, grammar and word choice (Bridwell, 1980; National Assessment of Educational Progress, 1977; Nold, 1981; and Perl, 1979).

Limitations on planning. When expert writers are asked to think aloud while they write they provide considerable evidence of goal-setting, planning, and problem solving. By comparison, there is a virtual absence of indications of such activity in the verbal reports produced by novices. This absence does not provide conclusive evidence of expert-novice differences since novices may simply be unable to verbalize their thoughts. Nonetheless, if young writers were carrying out significant amounts of planning, this activity would take time. Data on startup time (Zbrodoff, 1984) argue against any composing process that involves a great deal more deliberation than is hypothesized by the knowledge-telling model.

Limitations on achieving goals of literary forms. The knowledge-telling model predicts that novice texts will conform to the structural requirements of literary forms, although not necessarily achieving the goals of those literary types. In their longitudinal study of beginning writers, Rentel and King (1983) found that by the second year of school most children had begun to write stories that had the characteristic elements of narrative. But in a national assessment of stories by 17-year-olds, almost a third were judged to fall short of showing "evidence of the story-teller's obligation to structure a plot and elaborate it with appropriate details" (National Assessment of Educational Progress, 1980a, p. 14). Similarly, in persuasive writing knowledge telling ought at a minimum to produce a statement of belief accompanied by a list of reasons, but not a developed line of argument. Texts fitting this description proved to be the modal type for both 13-year-olds and 17-year-olds in the National Assessment of Educational Progress (1980b, 1980a) evaluations of persuasive writing.

Limitations on readability. In writer-based prose ideas are presented in a form and in an order that are reasonable from the standpoint of the writer's thinking of them but are not suited to the reader's uptake of the information (Flower, 1979). The knowledge-telling model hypothesizes a think-say composing process and limited means for operating on knowledge about reader reactions that could be expected to yield prose of this type. Flower has identified writer-based prose as a common form among university students.

Instruction: Current Efforts and Advances Toward Knowledge-Transforming Strategies

Many new things have started to happen in the teaching of writing. Children are encouraged to start writing before they have learned to read, inventing their own spellings (Clay, 1975). Some schools are greatly increasing the amount of time devoted to writing, and expressive and narrative forms are encouraged. Children are writing in teams or sharing their productions with one another in workshops (Crowhurst, 1979). Conferencing--the term used to describe teacher-student and student-student dialogue and feedback--is the mainstay of many progressive programs (Graves, 1983). Microcomputers are being used to produce presentable newspapers and other realistic applications of writing, and even for long distance communication among student writers (Quinsaat, Levin, Boruta, & Newman, 1983).

The above efforts have been inspired by the body of research that highlights the natural abilities that students bring to the task of writing. The educational means just listed are meant to capitalize on these natural endowments. By the same token, however, these currently popular approaches tend to avoid rather than contend with young writers' problems with knowledge use. In other words, the emphasis is not so much on solving writing problems as on making it easy for children to write well. The discourse forms encouraged--narrative and personal experience--are forms for which information as currently stored in memory is likely to lead to text with literary qualities. Furthermore, by encouraging social and communicative interchange throughout the production of the text it is possible to bring the task of writing closer to its conversational roots.

Children must, in time, cope with discourse forms that are less conducive to their natural talents, and they must incorporate into personal competence achievements that are now supported through social and conversational means. In effect, they must learn to do for themselves what the highly supportive school writing environment now does for them. A technique has been developed to enable novice writers to use more expert procedures than they are currently using and at the same time to place control of the procedure in their hands. The technique has been termed procedural facilitation. Procedural facilitation consists of routines and external aids designed to reduce the processing burden involved in taking on the advanced self-regulatory strategies of the expert. The main steps in designing a procedural facilitation are:

Step 1: Identify a self-regulatory function that appears to go on in expert performance but that does not go on or that goes on in an attentuated form in student performance: for instance, revision or planning.

Step 2: Describe the self-regulatory function as explicitly as possible in terms of mental operations or functions. Thus, revision can be described in terms of the mental operations of evaluating, diagnosing, choosing a revision tactic, and generating alternatives to previous text (Scardamalia & Bereiter, 1983). Planning can be described as a dialectic between rhetorical and content concerns (Scardamalia, Bereiter & Steinbach, 1984).

Step 3:Design external supports or teachable routines for reducing the information processing burden of the mental operation. For instance, in revision, to facilitate evaluation and diagnosis, we may reduce the task to a choice among a limited set of alternatives (e.g., "I'm getting away from the main point," "People will not understand what I mean here," "This is good"). Similarly, we may reduce choosing a revision tactic to a finite choice (e.g., delete, change wording, provide an example). The same principle of reducing problem analysis to a manageable set of alternatives can be applied to planning. A limited set of rhetorical ("I could be accused of exaggerating because..." "This is confusing because...") and substantive ("The opposite point of view would be..." "A consequence of this might be..." "This

is similar to...") concerns can be considered.

What we end up with, then, is a much simplified version of the self-regulatory function. The purpose of the simplification is to enable children to start performing the self-regulatory function with as little additional burden on their processing capacities as possible. As they become practiced at it, the function should begin taking even less capacity, so that the simplications can be withdrawn.

With procedural facilitation the prompts for reflective and evaluative thought are, literally, handed to the student. Procedural facilitations have to date been used to foster more expert-like revision and planning operations. Detailed accounts of these procedures can be found in Bereiter & Scardamalia, in press--b; Scardamalia & Bereiter, 1983; Scardamalia, Bereiter & Steinbach, 1984. A brief account of results using group instruction with grade 6 students follows:

Text changes. Facilitating revision led to significant increases in rated quality of texts. Results were not limited to advances on the part of particularly talented students, but were found for the class as a whole. Likewise, facilitating planning led to compositions judged to contain more reflective thought.

Longer planning. Grade 6 students went from not knowing how to spend more than 10 to 20 minutes on an assigned topic such as "Should boys and girls play on the same sports team?" to spontaneously spending four class sessions (each approximately 45 minutes) on parallel, assigned topics. A number of students spent additional time outside of class.

Higher-level revisions. As indicated above, student writing, even at the university level, is dominated by concerns of mechanics and word choice. After 9 hours of instruction, elementary school students showed a 100% increase in low-level revisions but an 800% increase in higher-level ideational revisions.

Internalizing and transferring new procedures. Evaluation has aimed to determine the extent to which performance demonstrated with procedural supports is also demonstrated

when supports are withdrawn. Experimental students have maintained an advantage when working on their own in test situations, although, especially for younger students, the advantage is attenuated when supports are withdrawn. As might be expected, results are more durable when the length of instruction is increased. Additionally, in one long term (one year) follow up students were found to have transferred operations learned in one context to new contexts.

Independent rather than teacher-dependent abilities. In studies using procedural facilitations care has been taken to insure that what students were able to achieve they did without help from peers or teachers. It is thus particularly significant that results have demonstrated significant improvements in underlying processes AND in texts produced. Frequently the most significant advances have been with students previously showing little talent. Also, with rare exception, it has been possible to trace improvement to each student in the class.

Strategy Change. The involvement of problem-solving processes rather than dealing with writing as a think-say routine is the main thing that distinguishes knowledge-transforming strategies from the knowledge-telling strategies. Results of procedural facilitations indicate students are incorporating knowledge-transforming procedures. They deal effectively with more varied and complex types of problems than same-age counterparts not using procedural facilitations. And these efforts are aided, not deterred by requiring children to shift attention between content generation and problem detection. This is a finding of much importance. It suggests that the primary means available to adults for reducing the load of writing--breaking the task into manageable subtasks--is available to immature writers under suitably facilitating conditions.

Suggestion of strategy change also comes from insights students demonstrate regarding the nature of expert strategies. Student responses to procedural facilitations have been virtually unanimous in declaring that evaluating and considering changes of their texts was a new experience for them, and they generally communicated a sense of having acquired

a new intellectual power, not just a procedural trick.

The above results have been obtained with group instruction and over periods of time of relatively short duration (approximately twelve to thirty 45-minute classroom sessions). As we clarify and refine our understanding of the underlying operations, even more effective procedures should prove teachable.

Assessment of Writing

In order to assess the effects of writing instruction on cognitive processes it is essential to have a model that indicates what development of cognitive processes in writing would consist of. It is popular at this time to distinguish between instruction that focuses on the "product" and that which focuses on the "process". But the word "process" means different things to different investigators, and current efforts almost universally lay claim to a process orientation. The following four types of outcome variables address distinctions that are meant to clarify issues regarding evaluation of instructional efforts. The point to be stressed is that educators should insist on convergent evidence from each type of outcome variable. Inferences based on select variables are risky and likely to be misleading.

Text Characteristics. The great bulk of instructional research, although it may employ quite nontraditional teaching methods, still focuses on text quality as the outcome of principal interest.

Surface behavior. One meaning of "process" is observable behavior such as taking notes, outlining, spending more time at writing, writing more words, and producing more changes or more drafts of a composition. Accordingly, instruction is successful if it leads students to show more of intended observable behaviors.

Cognitive behavior. Here the emphasis is on mental activities that lie behind the observable text and observable writing behavior: planning (which may or may not involve notes and outlines), rethinking or reprocessing (which may or may not involve physical changes to already-written text), etc.

Cognitive strategies. Here the emphasis is on the way cognitive behavior is organized in writing. The outcome of interest, therefore, is structural change (for example, incorporating knowledge-transforming procedures). Procedural facilitations, which make use of content-free external supports that are managed by the child, permit fairly precise gauging of what is available and what is lacking in students' strategic repertoires.

Most instructional evaluations are based on the first two types of outcome variables, and both of these can be highly misleading. Text quality can vary greatly depending on the topic assigned and on how much the student writes. Simply asking students to write more is sufficient to produce significant gains in rated quality of texts (Scardamalia, Bereiter & Goelman, 1982). Accordingly, gains in text quality do not necessarily mean that students have learned anything.

Changes in surface behavior can also be misleading. Seldom is the observable behavior valuable in itself. It has to be assumed that note-taking or outlining imply some worthwhile planning and organizing going on covertly and that changing words and moving text around imply constructive rethinking. To cite a cautionary example, a colleague of ours, examining a computer "dribble" file, was so impressed by the amount of revision activity recorded for one student that he went to watch the student at work. He discovered that the student whiled away unproductive moments at the computer by deleting bits of text and then making them reappear. The example would be trivial were it not that the pedagogical value of word processors is judged solely on the basis of text characteristics and surface behavior changes.

There is a more profound reason, however, for being dubious about instruction that focuses on text or surface behavior outcomes. Novices are already too dominated by what is on the surface. Difficulties in revision, planning and comprehension all appear to result from domination by tangible features of text (Brown & Day, 1983; Burtis, Bereiter, Scardamalia & Tetroe, 1983; Scardamalia & Bereiter, 1984).

Assessment of learning in writing must, of course, take account of text characteristics

and surface behavior, and often it will be impractical to obtain information on cognitive behavior and cognitive strategies. But to avoid being misled by superficial evidence, evaluators need to be able to assess data in light of coherent models of novice and expert competence. As indicated in the previous discussion of results of procedural facilitation, such models make it possible to judge what kind of changes have taken place in the students, and to combine a variety of kinds of evidence into a picture of where students are, where they are going, and what barriers still exist to their growth as writers.

Knowledge-Transforming Procedures within the General Context of Higher Order Skills.

When students were interviewed in the follow-up to the procedural facilitation aimed at reflective planning it was noted that many of them spontaneously referred to the instruction as having taught them "how to think" rather than how to write. It was interesting that after all our talk about writing they remembered the effort as being about thinking. Of course it was. This is the point of the knowledge-transforming model. It is a model of how experts invoke self-regulatory strategies in their effort to give meaning and form to specific topics. Students learn to use the same general kinds of problem-solving efforts that distinguish experts in other domains--shifting attention between different problem possibilities, evaluating alternatives, redefining goals as the problem emerges rather than rigidly adhering to a predetermined course of action.

Student reactions help buttress the claim that the self-regulatory mechanisms that typify expert procedures can contribute not only to immediate performance but also to further development (Flavell, 1979). In contrast to self-directed regulatory mechanisms contemporary school practices of all kinds seem to encourage more passive strategies. One set of school practices favors passivity by continually telling students what to do. Pearson and Gallagher (1983) report that it is common for elementary school teachers to restate the content of every text passage for students, on the assumption that many will have failed to grasp it. Another common set of school practices favors passivity by encouraging students to follow their spontaneous interests and impulses. The failure of many adolescents to perform

at a formal level on Piagetian tasks (Lawson & Renner, 1974) may be taken as symptomatic, in so far as formal thought involves deliberate operations on one's knowledge. Largely absent from current schooling efforts, scarcely even contemplated, are school practices that encourage students to assume responsibility for what becomes of their minds.

The higher order of educational objective that research in writing points to involves imparting to students those kinds of competence that have previously been reserved for the teacher. It has been the teacher who is expected to know what is worth learning and how it relates to what was learned previously. It has been the teacher's job to establish links between current activities and the student's needs and interests. It has been the teacher's job to recognize an original idea and to fan it into a flame. It has been the teacher's job to ask the probing question, to reveal the unexamined premise. Expert performance clearly demonstrates that these executive procedures are, for expert problem solvers, under self-direction. Writing would seem to offer an especially promising domain in which to help students develop such procedures.

Enabling students to develop a knowledge-transforming model of composing--a model that permits them to set and pursue their own goals in writing--seems likely to require more than simply a rich diet of relatively unrestricted writing experience, with a teacher involved as collaborator, respondent, and guide. The following additional elements appear necessary:

1. Students (and teachers) need to be made aware of the full extent of the composing process--that it is not just what one does while putting words on paper but that it includes the setting of goals, complex memory searches, formulation of problems, and so on. It needs to be constantly clear to students that the ultimate goal is that they should be able to take charge in a competent way of the whole process.

2. The problems of acquiring higher levels of competence need to be made the students' problems and not only the teacher's. Ideally, this should mean getting students involved in inquiries and problem-solving experiments that they will find fascinating and illuminating.

3. The teacher needs to model for the students and the students need to model for each other those major aspects of the composing process that do not normally show. What particularly needs to be modeled is the process of leading oneself to new insights through reflection. Of course, experts as well as novices run into many problems along the way. For experts these problems serve as important clues. Young students, by comparison, tend to feel threatened by problems and thus avoid them. Part of what students need to gain is an understanding of the "debugging" process that adults go through, and encouragement to treat "bugs" and confusions as important sources of date.

4. The use of procedural facilitation--simplified routines and external supports--can help students get a start on more complex processes. As much as possible, however, the students need to share in an understanding of the purpose, of where the facilitation is supposed to be helping them go. Without such purposefulness, students are likely to assimilate the new procedure to their existing one and thus obtain only superficial benefits.

Analogous ways of fostering higher order abilities have begun to show effect in reading comprehension (Bird, 1980; Palincsar & Brown, 1984). In domains such as mathematics and science, where there are not only skills but bodies of content to master, the problems of higher order abilities are somewhat different. But if students can develop powerful knowledge-transforming skills in writing and reading, this could go a long way toward enabling them to become active builders of their own knowledge in all domains.

References

Bereiter, C., & Scardamalia, M. (1983). Does learning to write have to be so difficult? In A. Freedman, I. Pringle, & J. Yalden (Eds.), Learning to write: First language, second language (pp. 20-33). New York: Longman Inc.

Bereiter, C., & Scardamalia, M. (in press-a). Cognitive coping strategies and the problem of "inert knowledge". In S. S. Chipman, J. W. Segal, & R. Glaser (Eds.), Thinking and learning skills: Current research and open questions (Vol. 2) Hillsdale, NJ: Lawrence Erlbaum Associates.

Bereiter, C., & Scardamalia, M. (in press-b). The psychology of written composition. Hillsdale, NJ: Lawrence Erlbaum Associates.

Bird, M. (1980). Reading comprehension strategies: A direct teaching approach. Unpublished doctoral dissertation, The Ontario Institute for Studies in Education,Toronto.

Bridwell, L. S. (1980). Revising strategies in twelfth grade students' transactional writing. Research in the Teaching of English, 14, 107-122.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering, and understanding. In J. H. Flavell & E. M. Markman (Eds.), Handbook of child psychology: Vol. 3. Cognitive development (4th ed.) (pp. 77-166). New York: John Wiley & Sons.

Brown, A. L., & Day, J. D. (1983). Macrorules for summarizing texts: The development of expertise. Journal of Verbal Learning and Verbal Behavior, 22(1), 1-14.

Burtis, P. J., Bereiter, C., Scardamalia, M., & Tetroe, J. (1983). The development of planning in writing. In G. Wells & B. M. Kroll (Eds.), Explorations in the development of writing (pp. 153-174). Chichester, England: John Wiley & Sons.

Clay, M. M. (1975). What did I write: Beginning writing behaviour. Auckland, New Zealand: Heinemann Educational Books.

Cooper, C., Cherry, R., Gerber, R., Fleisher, S., Copley, B., & Sartinsky, M. Writing abilities of regularly-admitted freshmen at SUNY/Buffalo. Unpublished manuscript, University

Learning Center, State University of New York, Buffalo, NY.

Crowhurst, M. (1979). The writing workshop: An experiment in peer response to writing. Language Arts, 56(7), 757-762.

Daly, J. A., & Miller, M. D. (1975). Further studies on writing apprehension: Sat scores, success expectations, willingness to take advanced courses, and sex differences. Research in the Teaching of English, 9, 242-249.

Evans, G. (1984). How much in control? A view of adolescent and adult performance in four task areas. Paper presented at the Centre for Applied Cognitive Science, Toronto, Ontario.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34, 906-911.

Flower, L. S. (1979). Writer-based prose: A cognitive basis for problems in writing. College English, 41(1), 19-37.

Flower, L. S., & Hayes, J. R. (1980a). The cognition of discovery: Defining a rhetorical problem. College Composition and Communication, 31(2), 21-32.

Flower, L. S., & Hayes, J. R. (1980b). The dynamics of composing: Making plans and juggling constraints. In L. W. Gregg & E. R. Steinberg (Eds.), Cognitive processes in writing (pp. 31-50). Hillsdale, NJ: Lawrence Erlbaum Associates.

Flower, L. S., & Hayes, J. R. (1981). The pregnant pause: An inquiry into the nature of planning. Research in the Teaching of English, 15, 229-244.

Goodman, K. S. (1967). Reading: A psycholinguistic guessing game. Journal of the Reading Specialist, 6, 126-135.

Graves, D. H. (1983). Writing: Teachers and children at work. Exeter, NH: Heinemann Educational Books.

Harste, J. C., & Burke, C. L. (1980). Examining instructional assumptions: The child as informant. Theory Into Practice, 19, 170-178.

Lawson, A. E., & Renner, J. W. (1974). A quantitative analysis of responses to Piagetian tasks and its implications for curriculum. Science Education, 58(4), 545-559.

Lowenthal, D. (1980). Mixing levels of revision. Visible Language, 14(4), 383-387.

Murray, D. M. (1978). Internal revision: A process of discovery. In C. R. Cooper & L. Odell (Eds.), Research on composing (pp. 85-103). Urbana, IL: National Council of Teachers of English.

National Assessment of Educational Progress (1975). Writing mechanics, 1969-1974: A capsule description of changes in writing mechanics. (Rep. No. 05-W-01). Denver, CO: National Assessment of Educational Progress.

National Assessment of Educational Progress (1977). Write/rewrite: An assessment of revision skills; selected results from the second national assessment of writing. (Tech. Rep.). U.S. Government Printing Office. (ERIC Document Reproduction Service No. ED 141 826).

National Assessment of Educational Progress (1980a). Writing achievement, 1969-79: Results from the third national writing assessment (Vol. 1: 17-year-olds). (Tech. Rep.). Denver, CO: National Assessment of Educational Progress. (ERIC Document Reproduction Service No. ED 196 042).

National Assessment of Educational Progress (1980b). Writing achievement, 1969-79: Results from the third national writing assessment (Vol. II: 13-year-olds). (Tech. Rep.). Denver, CO: National Assessment of Educational Progress. (ERIC Document Reproduction Service No. ED 196 043).

Nold, E. W. (1981). Revising. In C. H. Frederiksen & J. F. Dominic (Eds.), Writing: The nature, development and teaching of written communication (pp. 67-79). Hillsdale, NJ: Lawrence Erlbaum Associates.

Odell, L. (1980). Business writing: Observations and implications for teaching composition. Theory into Practice, 19(3), 225-232.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and monitoring activities. Cognition and Instruction, 1, 117-175.

Pearson, P. D., & Gallagher, M. C. (1983). The instruction of reading comprehension. Contemporary Educational Psychology, 8, 317-344.

Perl, S. (1979). The composing processes of unskilled college writers. Research in the Teaching of English, 13, 317-336.

Quinsaat, M. G., Levin, J. A., Boruta, M., & Newman, D. (1983). The use of a word processor in classrooms. Paper presented at the meeting of the American Educational Research Association, Montreal.

Reif, F., & Heller, J. I. (1982). Knowledge structure and problem solving in physics. Educational Psychologist, 17, 102-127.

Rentel, V., & King, M. (1983). Present at the beginning. In P. Mosenthal, L. Tamor, & S. Walmsley (Eds.), Research on writing: Principles and methods (pp. 139-176). New York: Longman Inc.

Resnick, L. B. (1983). Mathematics and science learning: A new conception. Science, 220, 477-478.

Scardamalia, M., & Bereiter, C. (1983). The development of evaluative, diagnostic, and remedial capabilities in children's composing. In M. Martlew (Ed.), The psychology of written language: Developmental and educational perspectives (pp. 67-95). London: John Wiley & Sons.

Scardamalia, M., & Bereiter, C. (1984). Development of strategies in text processing. In H. Mandl, N. Stein, & T. Trabasso (Eds.), Learning and comprehension of text (pp. 379-406). Hillsdale, NJ: Lawrence Erlbaum Associates.

Scardamalia, M., & Bereiter, C. (in press-a). The development of dialectical processes in writing. In D. Olson, N. Torrance, & A. Hildyard (Eds.), Literacy, language and learning: The nature and consequences of reading and writing. New York: Cambridge University Press.

Scardamalia, M., & Bereiter, C. (in press-b). Written Composition. In M. Wittrock (Ed.), Handbook of Research on teaching (3rd ed.). New York: Macmillan Education Ltd.

Scardamalia, M., Bereiter, C., & Goelman, H. (1982). The role of production factors in writing ability. In M. Nystrand (Ed.), What writers know: The language, process, and structure of written discourse (pp. 173-210). New York: Academic Press.

Scardamalia, M., Bereiter, C., & Steinbach, R. (1984). Teachability of reflective processes in written composition. Cognitive Science, 8(2), 173-190.

Scardamalia, M., & Paris, P. (in press). The function of explicit discourse knowledge in the development of text representations and composing strategies. Cognition and Instruction .

Smith, F. (1971). Understanding reading: A psycholinguistic analysis of reading and learning to read. New York: Holt, Rinehart & Winston.

United States National Commission on Excellence in Education. (1983). A nation at risk. Washington, D.C.: U.S. Department of Education.

White, B. Y. (1984). Designing computer games to help physics students understand Newton's Laws of Motion. Cognition and Instruction, 1(1), 69-108.

Writers at Work: The Paris Review Interviews, 2nd Series (1963). New York: The Viking Press.

Zbrodoff, N. J. (1984). Writing stories under time and length constraints. Unpublished doctoral dissertation, University of Toronto,Toronto.